WPS5443

Policy Research Working Paper 5443

Poverty and Inequality Maps for Rural Vietnam

An Application of Small Area Estimation

Nguyen Viet Cuong
Tran Ngoc Truong
Roy van der Weide

The World Bank
Development Research Group
Poverty and Inequality Team
October 2010

Policy Research Working Paper 5443

Abstract

The objective of the paper is to update the small area estimates of poverty and inequality for rural Vietnam. The new estimates of province and district level poverty for the year 2006, when combined with estimates available for 1999, allow for examination of how poverty has changed in rural Vietnam over the past seven years. The analysis finds that all provinces across the country experienced a noticeable reduction in rural poverty during the period 1999–2006. Some of the largest reductions in poverty are observed for provinces with poverty rates close to the national average. The poorest provinces have also experienced reductions in poverty, albeit at a more modest pace. Provinces and districts with lower levels of inequality in 2006 have seen above average poverty reductions. The authors consider both expenditure and income based measures of poverty and inequality, and find the results to be very similar.

This paper—a product of the Poverty and Inequality Team, Development Research Group—is part of a larger effort in the department to derive and disseminate disaggregated estimates of poverty and inequality. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at rvanderweide@worldbank.org.

Poverty and Inequality Maps for Rural Vietnam: An Application of Small Area Estimation

Nguyen Viet Cuong
Tran Ngoc Truong
Roy van der Weide[1]

JEL classification: I31, I32, O15

Keywords: Poverty measurement, poverty mapping, agricultural census, household survey, Vietnam.

[1] Nguyen Viet Cuong is a lecturer at the National Economic University; Tran Ngoc Truong is a researcher at the Institute of Labor Science and Social Affairs (ILSSA), Roy van der Weide is affiliated with the Poverty and Inequality Research group at the World Bank. This report documents the main findings of the poverty mapping project initiated by Dr. Nguyen Thi Lan Huong from ILSSA, MOLISA and funded by the World Bank in Vietnam. We would like to thank Gian Thanh Cong from ILSSA, Le Trung Hieu and Lo Thi Duc from GSO for their help and comments. The logistic and financial supports have been provided by the World Bank in Vietnam and the Institute of Labor Science and Social Affairs, Ministry of Labors, Invalid and Social Affairs.

I. Introduction

Vietnam has set up poverty reduction as a major development policy. To achieve this goal, Vietnam has maintained an extensive public safety net and launched a large number of poverty reduction programs. These programs generally benefit from having precise information on where the poor are located, and on how poor they are, see e.g. Bigman and Fofack (2000) and Elbers *et al.* (2007).

The objective of this study is to estimate poverty and inequality for rural Vietnam at different levels of aggregation by combining the Vietnam Household Living Standard Survey (VHLSS) from 2006 and the Rural Agriculture and Fishery Census from the same year. We will produce estimates at the regional, provincial and district level, and will consider both expenditure and income based measures. The estimates are obtained by adopting the small area estimation method put forward by Elbers *et al.* (2003) (henceforward ELL), which has since been used to put poverty on the map in over 40 countries worldwide.

The information on all households provided by the census combined with the detailed information on selected households from the survey makes it possible to estimate poverty at levels of aggregation the survey alone does not allow for. The standard errors of our province level estimates are comparable to the standard errors of the region level estimates based on survey data only. The standard errors of our district level estimates are obviously larger, but still acceptable.

The use of the agricultural census denotes a modest variation on the approach of ELL, which conventionally uses a population census instead. The motivation for appealing to the agricultural census is that the population census is only available once every ten years. In Vietnam, the agricultural census is conducted every five years. This means that by alternating the population census with the agricultural census we are able to triple the frequency of poverty and inequality estimates at the small area level. The latter is important as it makes the small area estimation exercise a more suitable tool to monitor poverty and inequality over time, channel resources when and where they are most needed, and to evaluate poverty reduction initiatives across the different areas in Vietnam.

While replacing the population census with the agricultural census does not require any methodological changes, there are some differences worth noting. Most importantly, the agricultural census only allows us to provide estimates for rural Vietnam, where the population census covers both rural and urban areas. Also, the two different census data sets each have their own specific variables, in addition to a standard set of

variables that they have in common. Plausibly, the agricultural census is in comparison more informative of rural livelihoods.

Other poverty maps of Vietnam that have been constructed in the recent past include: Minot (2000) who combined the Vietnam Living Standard Survey (VLSS) from 1993 and the Agricultural Census from 1994 to estimate rural poverty at the province and district level; Minot *et al.* (2002) and Gian and van der Weide (2007) combined the 1998 VLSS and a 33 percent sample of the population census from 1999. Fujii and Roland-Holst (2008) study the effects of Vietnam's access to WTO on poverty. They too combine the 1998 VLSS and a 33 percent sample of the 1999 population census to estimate provincial poverty rates. Nguyen et al. (2007) attempt to bridge the three-year gap between the Vietnam Household Living Standard Survey (VHLSS) from 2002 and the 1999 population census to estimate poverty levels for 2002. Nguyen et al. (2005) and Nguyen et al. (2007) produce a district map of poverty and inequality of Ho Chi Minh City for the year 2004. Recently, most of these poverty maps, however, are out-of-date.

The paper is structured into seven sections. The second section describes data sources. The third section presents the method of small area estimation of Elbers *et al.* (2003). The poverty and inequality estimates and the models used for respectively the expenditure and income based measures are reported in sections four and five. Section six compares the estimates of expenditure based poverty to those based on income, and the poverty rate reported by the Ministry of Labour, War Invalids and Social Affairs. Finally, concluding remarks are presented in section seven.

II. Data

II.1 Household survey and agricultural census

The two data sources used are: The Vietnam Household Living Standard Survey (VHLSS) for 2006 and the 50 percent sample of the Rural Agriculture and Fishery Census (ARFC) for 2006. Both data sets have been collected by the General Statistic Office of Vietnam (GSO).

The VHLSS 2006 includes 9189 households (with 39071 individuals), of which 2250 are urban and 6939 rural households. The collected information on household characteristics includes: income, expenditure, employment status, education level, housing condition, fixed assets owned by household. The survey is designed to be representative at the regional level. This means that the survey is not able to guarantee consistent poverty estimates at lower levels of aggregation (such as at the province level).

The Rural Agriculture and Fishery Census (RAFC) includes all households in rural areas, and is conducted every five years. While the agricultural census and the population census have a range of variables in common (demographics, education, dwelling unit characteristics and asset ownership), there are also some important differences.

Firstly, the agricultural census only covers rural households such that the small area poverty and inequality estimates represent the rural population of Vietnam. Estimates based on the population census represent the entire population.

Secondly, the agricultural census includes a selection of specific variables that are particularly informative of rural livelihoods and which are not available in the population census. These include variables on rice cultivation, aquatic cultivation, household ownership of farming tools and machinery. These variables are important correlates of the household's agricultural activities that will directly affect the household's income.

Data on individual household members, however, is only collected for members aged 15 or older (the population census covers all household members). To ensure consistency between the variables from the census and the survey, household members aged 14 or younger were dropped from the latter. Also, the head of household is not identified in the agricultural census.

Finally, the codes that identify communes, districts and provinces did not provide a perfect match between the census and the survey. We managed to resolve this problem by using the names of both the provinces and districts to merge data from different sources.

II.2 Poverty line

In the report we use two poverty lines: one for expenditure and one for income. Household members are classified as poor if their per capita expenditure (income) is below the expenditure (income) poverty line.

GSO calculated the expenditure poverty line with technical support from the World Bank in Vietnam. The expenditure poverty line is designed to measure the price of a consumption basket that meets pre-specified nutritional needs and essential non-food expenditures that include clothing and housing. For 2006, the expenditure poverty line was equal to 2,560,000 VND/person/year (in national real terms).

The income poverty line is set by MOLISA. It equals 2,400,000 VND/person/year (200,000 VND per month) for the year 2006 (in national real terms). When this poverty line is applied to household income data from the 2006 VHLSS, however, we obtain a

poverty estimate for rural Vietnam of around 7.5 percent. This is considerably lower than the MOLISA rural poverty rate of 19 percent for that same year.

Although, MOLISA sets up an income poverty line to identify poor households, this poverty line is not applied since collection of income for the whole population is very costly, and almost impossible. In reality, the poverty classification procedure is rather complicated. Basically, a village committee prepares a list of the poor based on their own criteria, which may, for example, include asset levels, food security, type of housing, and school-going of children. The number and nature of the criteria differ widely between villages. The preliminary list is submitted to a commune-level committee of Hunger Eradication and Poverty Reduction (HEPR), which might conduct a very simple income survey for some households on the list. These surveyed households are expected to have income around the poverty line, thus their income data should be collected for cross-check. The resulting incomes are compared to the income poverty line of the Ministry of Labour, War Invalids and Social Affairs (MOLISA). Those households with higher per capita income than this poverty line are excluded from the list. Finally, the refined list is updated by the village committee and the People's Committee and People's Council in an iterative procedure (MOLISA, 2003). Thus there is a large difference between the poverty estimates based on the VHLSS and the poverty incidence reported by MOLISA.

To facilitate comparisons between our income poverty estimates and the income-based poverty rates from MOLISA, we adjust the income poverty line such that income poverty estimated using the 2006 VHLLS coincides with the MOLISA poverty rate (at around 18.5 percent for rural areas in 2006). The income poverty is set at 3,288,000 VND/person/year (in national real terms).

III. Methodology

The small area estimation method developed by Elbers, Lanjouw and Lanjouw (2002, 2003) is arguably most popular in the context of poverty analysis. In ELL two data sets, a socio-economic survey and a census are combined through an income or expenditure model. This combination allows us to obtain small area estimates (SAE) of income or expenditure based poverty and inequality. By using the survey alone, we would only be able to disaggregate at the region level.

Typical indicators considered are average expenditure/income, percentage of poor (with expenditure/income below poverty line), poverty density (number of poor per area) and the Gini coefficient. We will determine both the point estimates and the standard errors associated with them. The standard errors are important because they make explicit

the trade-off between the statistical precision of the poverty and inequality estimates and the level of disaggregation.

The census is assumed to enjoy complete coverage (of all rural households), such that sampling error may safely be ignored. The basic idea behind the small area estimation method is to replace a small number of exact observations of expenditure/income (using households from the survey) with a large number of estimates of expenditure/income (using households from the census) to obtain accurate estimates of aggregate poverty and inequality. This means that we will be replacing sampling error with approximation error. As approximation errors cancel out on average, the errors induced by approximation tend to be small when the number of households is large.

III.1 The ELL framework

Let us provide a brief review of the ELL methodology. In the standard setup, we consider the following model:

$$\ln(y_{ch}) = x_{ch}^T \beta + \eta_c + \varepsilon_{ch}, \qquad (1)$$

Where $\ln(y_{ch})$ denotes the dependent variable (think of logarithmic per capita expenditure), x_{ch} the vector of explanatory variables, β the vector of regression coefficients, η_c the cluster-specific random effect and ε_{ch} the household-specific random effect. The subscript *ch* refers to household *h* living in cluster *c*. The explanatory variables x_{ch} must be available in both census and survey. The household specific errors are assumed to be independent from each other, and independent from the cluster error.

Once all the parameters of interest have been identified, the dependent variable is imputed into the census:

$$\hat{\ln}(y_{ch}) = x_{ch}^T \hat{\beta} + \hat{\eta}_c + \hat{\varepsilon}_{ch}, \qquad (2)$$

where $\hat{\beta}$, $\hat{\eta}_c$ and $\hat{\varepsilon}_{ch}$ denote the estimates for β, η_c and ε_{ch}. Now suppose that we want to estimate poverty for a given district. As an illustrative example, let us consider the head-count index, which measures the percentage of poor households in the district:

$$W = \frac{1}{n} \sum_{ch} 1_{(y_{ch} < z)}, \qquad (3)$$

where $1_{(y_{ch} < z)}$ denotes the indicator function that equals 1 if $y < z$ and 0 otherwise, and where *n* denotes the number of households living in the district. An estimate of W can be obtained by replacing y_{ch} with $\hat{y}_{ch}$ for all households *ch*.

For accurate estimation of the standard error of W, ELL advocate repeated Monte-Carlo simulations. In each round, a simulated regression coefficient $\tilde{\beta}^{(r)}$ is drawn (from its estimated distribution), where r denotes the *r-th* round of simulation. Further, $\tilde{\eta}_c^{(r)}$ and $\tilde{\varepsilon}_{ch}^{(r)}$ are drawn from their estimated distributions, which means we will have a simulated cluster error for each cluster and a simulated household error for each household in the census. The imputed dependent variable for household h in cluster c, in the r-th round, is therefore given by:

$$\tilde{\ln}(y_{ch})^{(r)} = x_{ch}^T \tilde{\beta}^{(r)} + \tilde{\eta}_c^{(r)} + \tilde{\varepsilon}_{ch}^{(r)}, \qquad (4)$$

Each round of simulation yields a new estimate $\tilde{W}^{(r)}$. By taking the average and standard deviation over the *r* different simulated values of $\tilde{W}^{(r)}$, we obtain both the point estimate and the corresponding standard error.

In this paper, we use measure poverty using three Foster-Greer-Thorbecke (FGT) poverty indexes including the poverty headcount index, poverty gap index and poverty severity index (see Foster et al, 1984). Inequality is measured by the Gini coefficient. The FGT indexes and Gini index are the most popular measures of poverty and inequality, especially for developing countries. They are often reported in poverty assessment studies in Vietnam such as Vietnam Development Reports (see World Bank, 2003; World Bank, 2007).

III.2 Two key assumptions

The ELL method is based on two key assumptions:

The model is accurate at each level it is applied: Tarozzi and Deaton (2007) refer to this as the `area homogeneity' assumption. While the model is typically estimated at the regional level, predicted expenditures are aggregated over much smaller areas (think of provinces and districts). Consistency therefore requires that any omitted variables, which end up in the error term, have zero expectation at any level of aggregation.

Spatial correlation is accurately accounted for: The errors for different households are likely to exhibit a level of correlation, in particular when the households live close to each other such that they are subject to similar (unobserved) geographical effects. An accurate account of this spatial correlation is important for the precision of the standard errors of the SAEs.

ELL accommodate spatial correlation by assuming that the error can be decomposed into a cluster error (an error that is shared by all households living in the

same cluster) and a household specific error. The common error is referred to as location error. The household specific error will also be referred to as an idiosyncratic error. Empirical results from a wide range of countries indicate that spatial correlation is indeed significant, and that the approach put forward by ELL works quite well.

A violation of either of the two key assumptions will affect the precision of the SAEs. Therefore, each time the method is used, it is important that the user tests the validity of these assumptions, as this may vary from country to country. Specifically, if one decides to ignore spatial correlation, while it is in fact present, one runs the risk of significantly underestimating the standard errors, and hence overestimating precision.

IV. Estimates of Expenditure Poverty and Inequality

IV.1 Selection of explanatory variables

The first step in the poverty mapping exercise is to select the explanatory variables in the regression model with either expenditure or income as the dependent variable. These variables should meet the following criteria:

- Available in both the household survey and the census.
- Household survey and census are comparable (both questionnaires accommodate the same variable definition, and both data sets show similar summary statistics).
- Sufficiently correlated with household expenditure or income.

After carefully screening the questionnaires and examining the data (comparing summary statistics) of candidate common variables from the 2006 VHLSS and the 2006 RAFC, we selected 27 household variables which will be used as the explanatory variables in the models for expenditure and income.

We also constructed commune level data that was merged with the household level data. For selected household level variables from the 2006 ARFC we derived commune mean values, which were merged with the VHLSS at the commune level. For example, we construct the percentage of ethnic minorities of communes, the average household size of communes, etc. Note that these variables are comparable by construction. They are referred to as the `mean variables of communes'.

The commune (and district level) variables were complemented with GIS variables from third data sources. The list of all the explanatory variables is presented in Table A.1 in the Appendix.

IV.2 Expenditure models

This section will present the regression models used for (log) expenditure. There are eight geographical regions in Vietnam. To allow for geographical heterogeneity, we estimate a separate expenditure model for each region.

Our strategy of model selection is forward stepwise regressions. We start with a model including only one explanatory variable but providing the best fit. Then other variables are added one by one to the model to increase the goodness of fit. Thus different regions have different expenditure models. Overall, to avoid over-fitting, we tend to use models that are both relatively small and robust. To examine the sensitivity of the poverty estimates to model specifications, for each region, we compare two different models, which vary mostly in the number of explanatory variables they include. The poverty and inequality estimates from large and small models are found to be very similar. Interestingly, also when we compare standard errors, the differences are rather small. The poverty estimates obtained with the large model tend to come with relatively smaller standard errors. We are inclined to label the estimates from the larger model as more precise. In this paper, we will present the estimation results from the large models.

It should be noted that several explanatory variables such as assets, education, and employment can be endogenous in expenditure and income equations. Ideally, all explanatory variables should be exogenous. However, if we use only exogenous variables such as demography and GIS variables, the prediction power will be small. Thus, we have to use all available household variables. It is expected that the endogeneity of several variables is not a serious problem in the poverty map exercises, since our objective is to predict expenditure (or income) rather than to estimate the causal effect of explanatory variables on expenditure (or income).[2]

Tables A.2 to A.9 in the Appendix present the GLS regressions of the logarithm of per capita expenditure (the large models). The results were obtained using the latest version of the PovMap program (updated in March 2009).[3] The location effect was modeled at the district level. (The latter affects the estimates of the variance-covariance matrix and hence the GLS estimates of the model parameters.)

[2] Another issue is multicollinearity between explanatory variables. We calculated the variance inflation factor (VIF) for multicollinearity after regressions, and all most the estimates of VIF are below 5. It implies that the multicollinearity is not serious. In addition, we also report the correlation matrix of household explanatory variables in Table A.11 in Appendix.

[3] The program is developed by researchers of the World Bank.
http://iresearch.worldbank.org/PovMap/PovMap2/PovMap2Main.asp

It is found that all estimates of the model parameters make economic sense (have expected signs). Given the controlled variables, ethnic minorities still have lower per capita expenditure than Kinh and Hoa people. Households of large size are more likely to have lower per capita expenditure than households of small size. As expected, assets are positively correlated with per capita expenditure. Households who have more working members or members with vocational training tend to have higher expenditure. Finally, the R-squared values are quite encouraging with the range from 0.43 to 0.7.

IV.3 Poverty estimates

Regional estimates

Table 1 presents the estimates of the poverty incidence of the eight rural regions. It shows that the estimates from the small area estimation exercise are very close to the estimates based on the 2006 VHLSS (both for the large and small models). While we observe a noticeable difference for the Central Highlands, the difference is not statistically significant. The standard errors for the Central Highlands estimates based on the 2006 VHLSS are rather large due to the small number of observations.

The poorest region is the North West with a poverty rate of above 50 percent. In regions with low levels of poverty, about 10 percent of the rural population lives below the poverty line.

Table 1 The poverty incidence estimates of regions

Region	VHLSS 2006	Small area estimation
Red River Delta	11.0	11.3
	[1.1]	[0.9]
North East	29.9	31.6
	[1.8]	[1.6]
North West	56.4	57.3
	[3.7]	[2.6]
North Central Coast	33.1	32.9
	[2.4]	[1.7]
South Central Coast	17.1	17.8
	[2.1]	[1.2]
Central Highlands	34.4	39.9
	[3.7]	[2.0]
North East South	9.9	10.1
	[1.5]	[0.9]
Mekong River Delta	11.8	12.6
	[1.0]	[1.3]

Standard error in the brackets

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

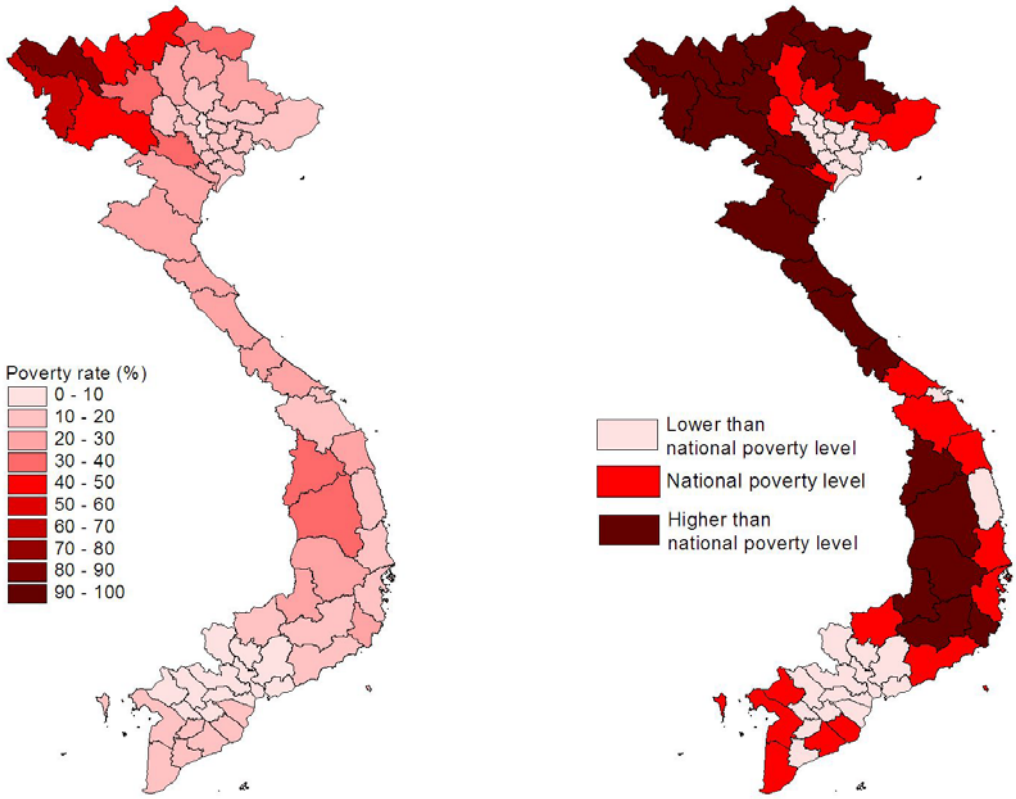
Provincial estimates

The estimates of provincial poverty are presented in Table A.10 in the Appendix.[4] It shows that the poorest provinces are Lai Chau, Dien Bien, Ha Giang, which have a poverty rate of over 60 percent. These provinces belong to the North West and North East. Cities such as Ho Chi Minh, Ha Noi, Binh Duong have very low rural poverty rates (below 5 percent). There is a considerable level of variation in provincial poverty rate within the regions. Estimates of the poverty gap, poverty severity and the Gini coefficient are also included.

The left panel of Figure 1 presents a map with the provincial poverty estimates. It can be seen that the North East and High Land regions tend to experience higher levels of poverty, while the delta regions (such as the Red River Delta and South East) are areas with lower levels of poverty.

Figure 1 Map of the provincial poverty rates

The poverty rate (%) Relative to national poverty



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

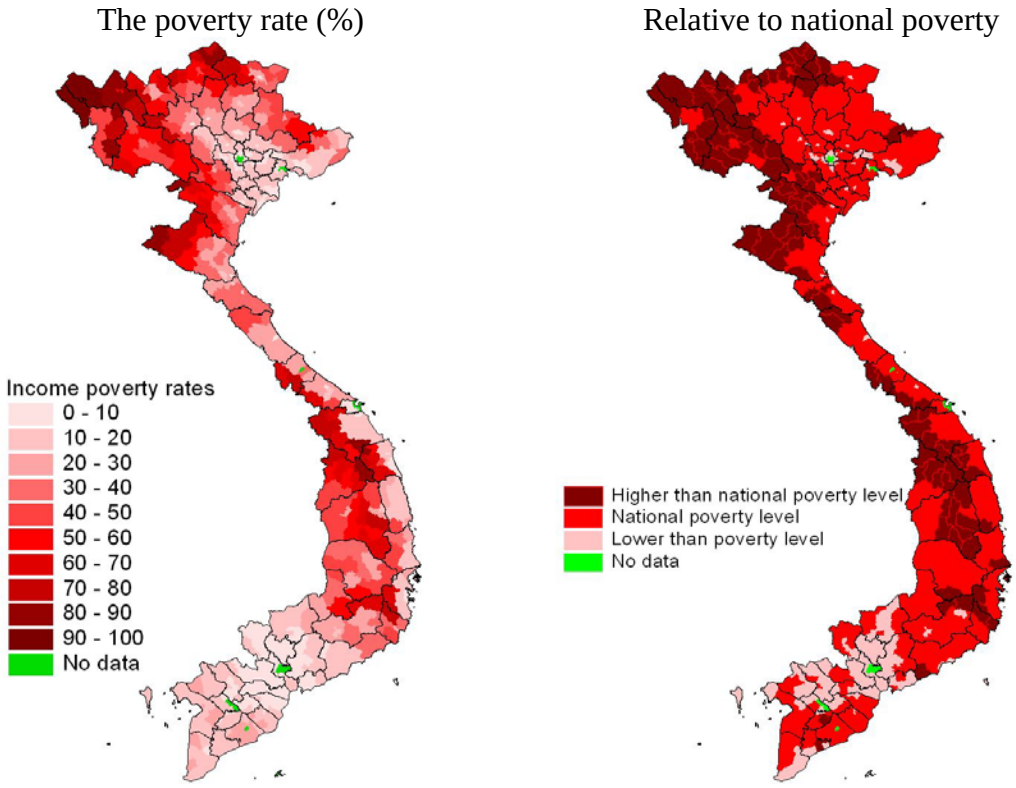
[4] In this table, we present the poverty headcount, poverty gap index and Gini coefficients. Detailed estimates of the poverty headcount, poverty gap index, poverty severity index and Gini coefficients of all the provinces and districts can be provided on request.

In the right panel of Figure 1, the standard errors of the poverty estimates are taken into account. Provinces are grouped into three groups: (i) provinces with poverty estimates that are significantly lower than the national poverty level (which is 20 percent), (ii) provinces with poverty estimates that are insignificant from the national poverty level, and (iii) provinces with poverty estimates that are significantly higher than the national poverty level.

District estimates

To improve poverty targeting, it is key to have precise poverty estimates at low levels of aggregation (such as districts and communes). While estimates at the commune level will be unreliable, due to the small number of households in communes and given that we only have a 50 percent rural sample of the 2006 ARFC, estimates of district poverty can be obtained with an acceptable level of precision. Figure 2 presents the maps with estimates of poverty at the district level.

Figure 2 The expenditure poverty incidence of districts



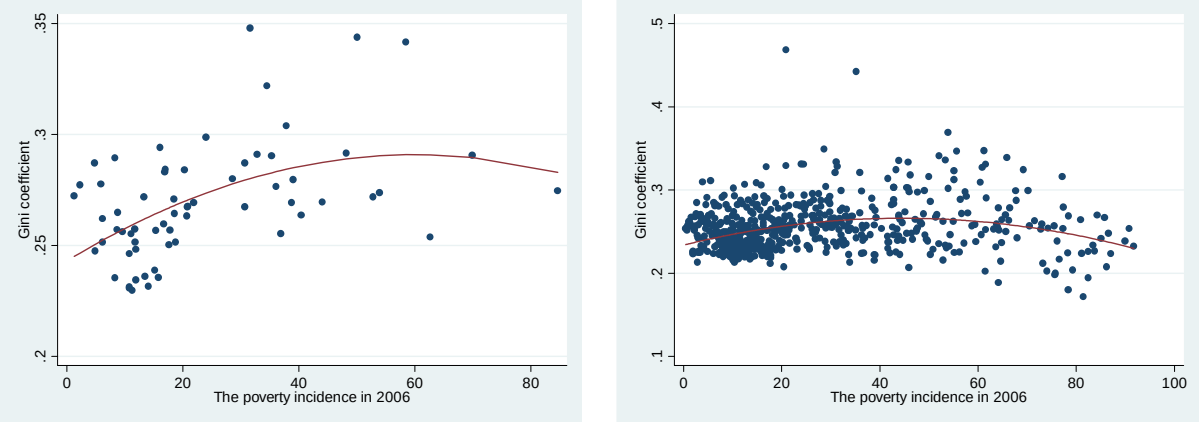
Source: Authors' estimation from VHLSS 2006 and ARFC 2006

IV.4 Inequality and poverty

We also examine the spatial pattern of expenditure inequality (the Gini coefficient) in Vietnam. The provincial estimates of the Gini coefficients can be found in Table A.10 in the Appendix. Inequality varies across provinces and districts albeit with small differences. Average inequality (based on expenditure) is rather low at 0.27 for provinces and 0.25 for districts. The province with the lowest Gini (0.23) is Thai Binh, while the province with the highest Gini (0.35) is Lam Dong. At the district level, the Gini coefficient varies from 0.17 to 0.47. Meo Vac disitrict of Ha Giang province has the lowest Gini (0.17), while Da Lat city of Lam Dong province has the highest Gini (0.47).

Interestingly, low levels of inequality are found in both the poorest provinces and the richest provinces. Figure 3 plots the relationship between poverty and inequality. The quadratic relationship is highly significant both at the province and district level. Inequality tends to be lower in areas with relative low poverty and areas with relatively high poverty rates, although the differences are not enormous. This finding is consistent with the Kuznets hypothesis that inequality first increases as the economy develops, and then decreases once a high level of economic development is reached.

Figure 3 Inequality (Gini index) and poverty (P0)

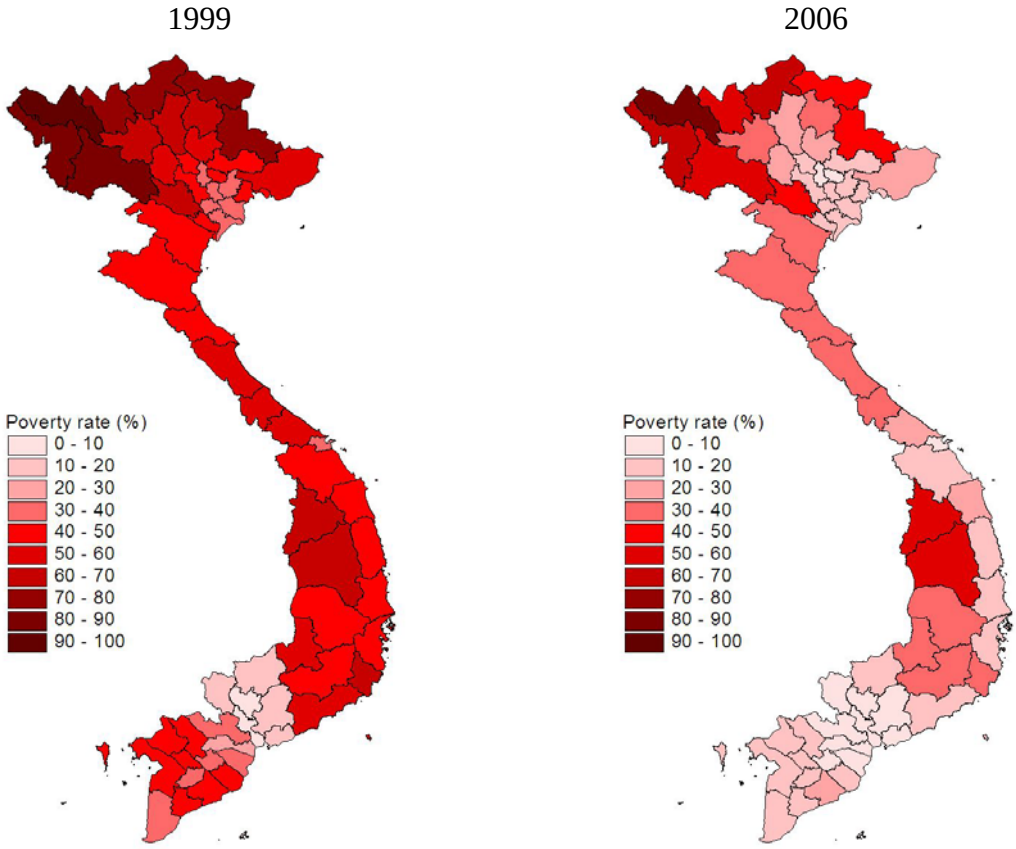


Source: Authors' estimation from VHLSS 2006 and ARFC 2006

IV.5 Poverty change during the period 1999-2006

Figure 4 compares the poverty maps for the years 1999 and 2006. This shows how poverty has been reduced across the country during 1999-2006. Virtually all provinces experienced a reduction in the poverty rate. The areas where progress has been slow are the poorest areas of the country (the North West of Northern and the North West of Southern Vietnam).

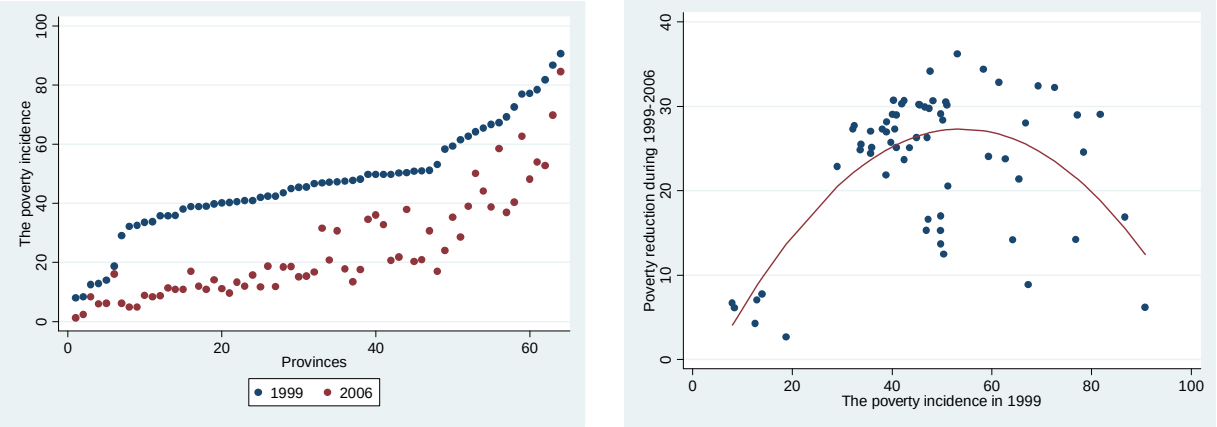
Figure 4 The provincial poverty incidence over 1999-2006



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 5 confirms that the poverty reduction is most noticeable in areas with an average level of poverty. It is of course not surprising that areas that had already achieved low levels of poverty in 1999 show smaller changes poverty in percentage points. What was not expected, however, is that the poorest areas have been relatively unsuccessful in reducing poverty.

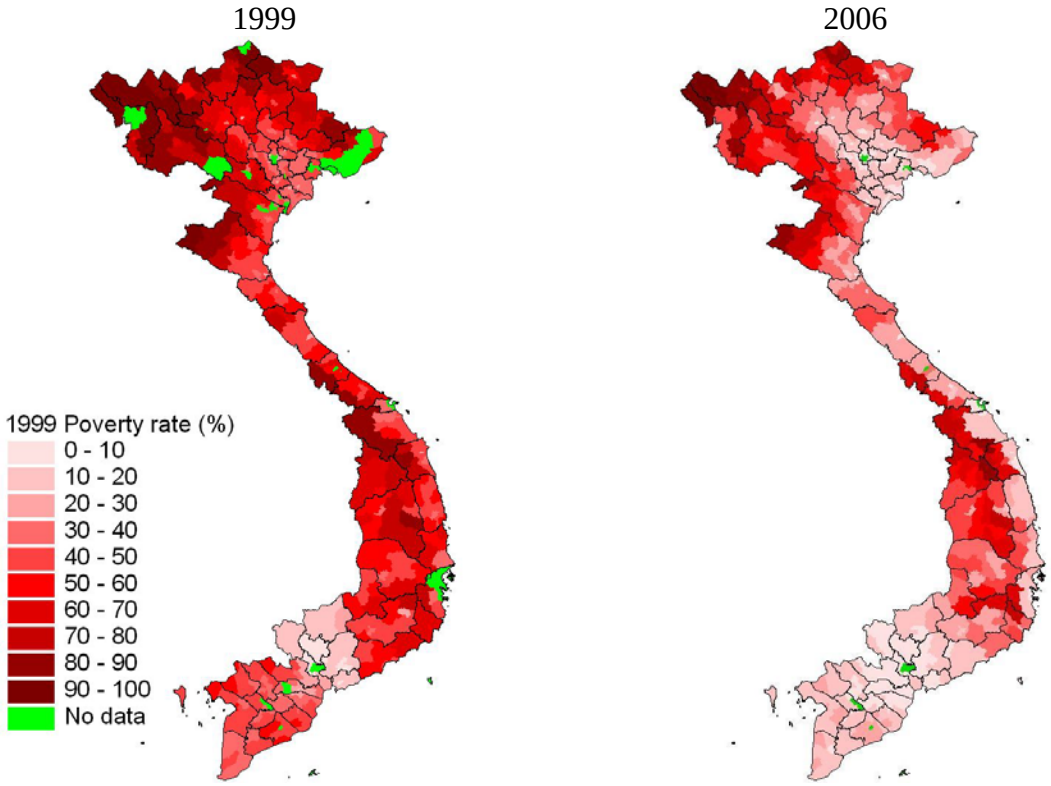
Figure 5 The provincial poverty incidence in 1999 and 2006



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

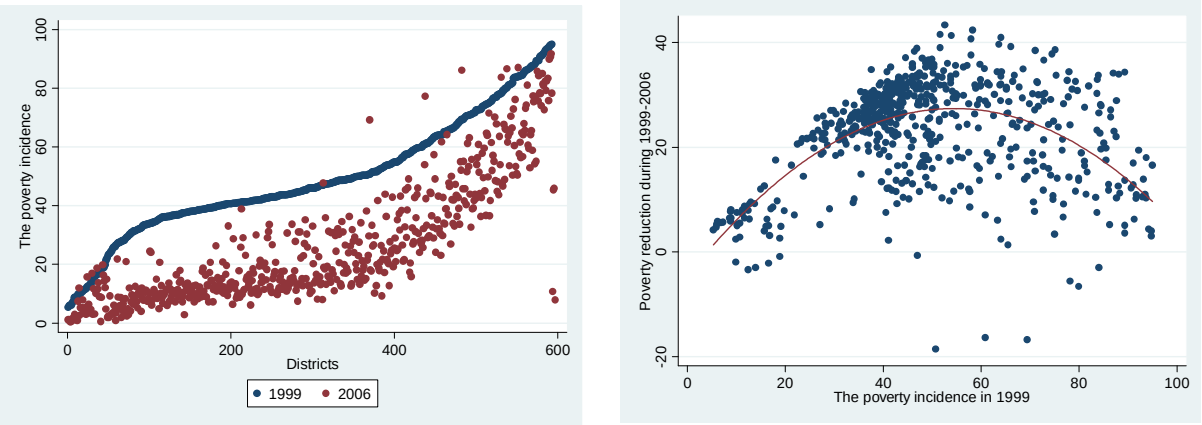
Figure 6 puts the estimates of district poverty for the years 1999 and 2006 on the map. Also here we see that districts with very low and very high poverty in 1999 experienced smaller reductions in poverty (see also Figure 7).

Figure 6 The district poverty incidence over 1999-2006



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

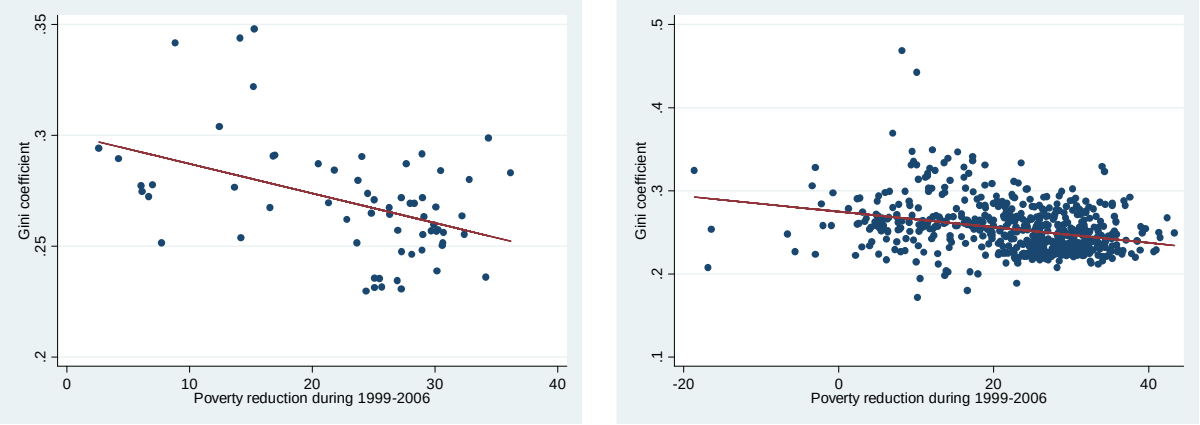
Figure 7 The district poverty incidence in 1999 and 2006



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 8 presents the relation between poverty reduction in the period 1999-2006 and the inequality level in 2006. It shows that provinces and districts with a larger poverty reduction in the period 1999-2006 tend to have a lower level of inequality in 2006. It means that poverty reduction can be associated with inequality reduction.

Figure 8 Poverty reduction and inequality during 1999-2006



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

V. Estimates of Income Poverty and Inequality

Since the government of Vietnam is using the income poverty line, we also estimate income poverty and inequality measures for provinces and districts.

V.1 Income models

We begin with constructing regression models for (log) income. Also here, we estimate two models for each of the eight regions, a large and a small model specification. The results from the large and small models are very similar. However, the large models produce lower standard errors of estimates. Thus, in this paper we present the estimation results from the large models.

Tables A.2 to A.9 in the Appendix present the GLS estimates for the large models. It shows that all model coefficients make economic sense (have expected signs).

V.2 Poverty and inequality estimates

Poverty estimates

Table 2 reports the estimates of the rural poverty incidence for all eight regions. The estimates are all very close to the estimates based on the 2006 VHLSS. The poorest region is North West with a poverty rate of just below 50 percent. With a poverty rate of around 8 percent, North East South is among the least poor regions.

Table 2 The income poverty incidences of regions

Region	VHLSS 2006	Small area estimation
Red River Delta	15.5	15.3
	[1.1]	[0.7]
North East	22.0	24.4
	[1.6]	[1.4]
North West	48.8	49.2
	[3.6]	[2.5]
North Central Coast	28.2	26.7
	[1.9]	[1.1]
South Central Coast	20.3	18.7
	[1.9]	[1.4]
Central Highlands	24.4	25.4
	[3.0]	[1.2]
North East South	7.7	8.6
	[1.2]	[1.2]
Mekong River Delta	11.5	11.0
	[0.9]	[1.0]

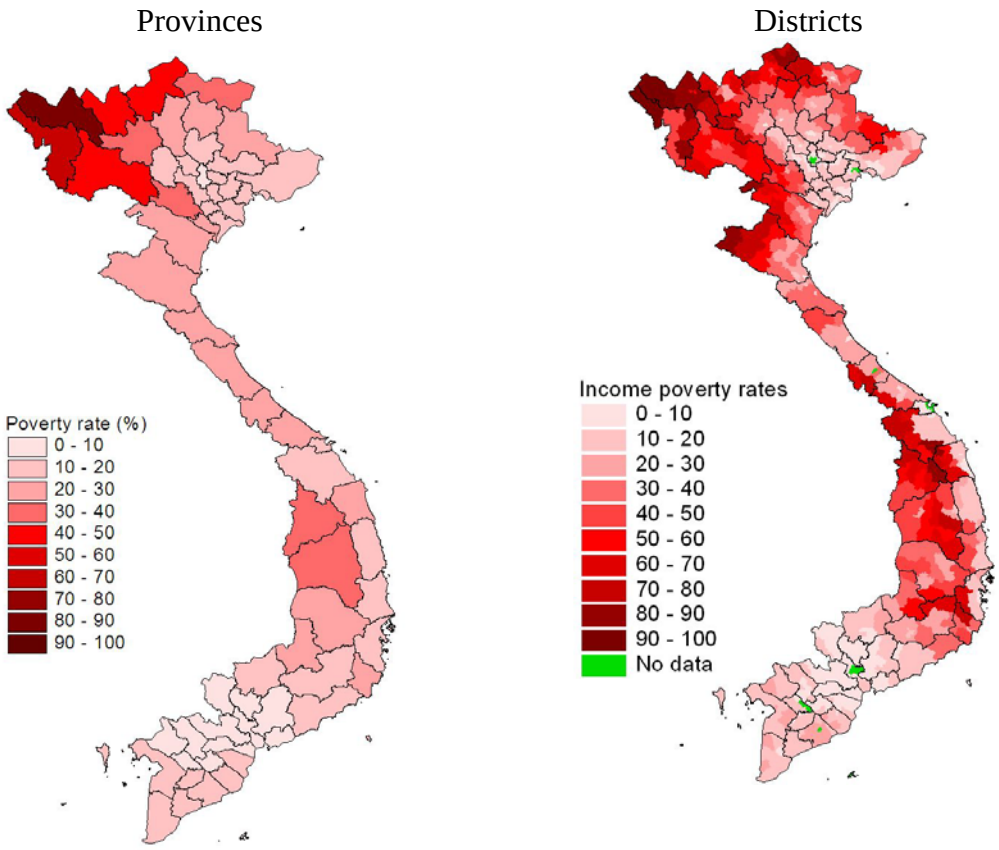
Standard error in the brackets

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Estimates of provincial poverty are reported in Table A.10. Similar to what we found for expenditure poverty, the poorest provinces are Lai Chau, Dien Bien, Ha Giang, with poverty rate of 50 percent and above. These provinces belong to North West and North East. The rural population in cities such as Ho Chi Minh, Ha Noi, Binh Duong experience low poverty rates. The poverty gap, poverty severity, and the Gini coefficient are also included.

Figure 9 shows a map of the income poverty incidence, and a map that compares the provincial poverty estimates with the national poverty rate (20 percent), taking into account the standard errors.

Figure 9 Map of the provincial and district income poverty incidence (%)



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Inequality

Income inequality measured by Gini coefficients are reported in Table A.10 in the Appendix. Income inequality is seen to be higher than expenditure inequality. The

average Gini for provinces and districts is 0.32 and 0.30, respectively. Income inequality estimates are lowest in the Binh Dinh province (0.28), and highest in Son La (0.57). The income inequality estimates for districts range from 0.19 (Nam Giang district, Quang Nam province) to 0.79 (Son La town of Son La province). Note that these results should be interpreted with care, as standard errors need to be taken into account.

VI. Comparison of Alternative Poverty Indicators

This section compares different indicators of poverty, which include expenditure poverty, income poverty and MOLISA poverty rates.

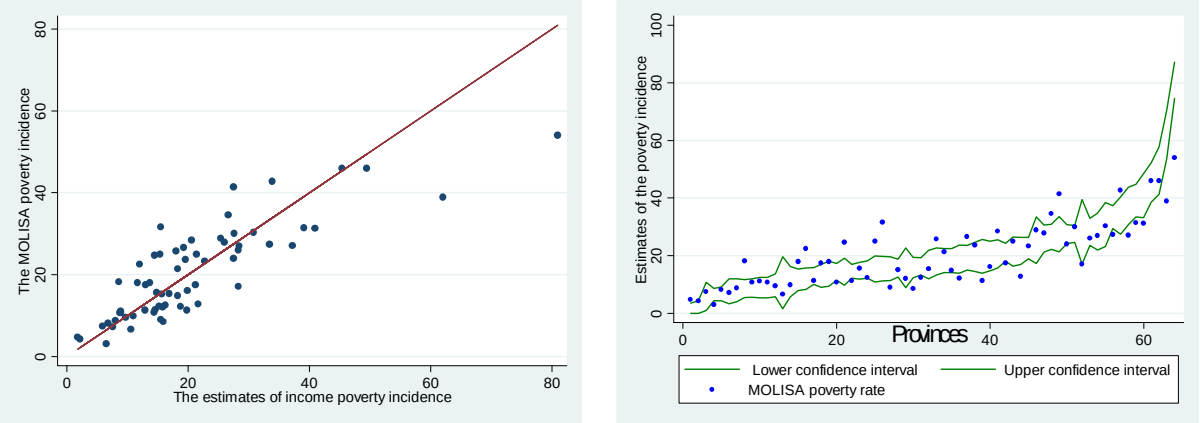
VI.1 Income poverty and MOLISA

Figure 10 compares the MOLISA poverty rates with the income poverty estimates at the province level. All estimates refer to the year 2006. The left panel provides a simple scatter plot. If the two poverty indicators are comparable, the points will be close to the diagonal line. The two different indicators are clearly related. Judging whether the observed differences are significant is not straightforward. Firstly, we do not have the MOLISA poverty rates for rural areas: the MOLISA poverty rate represents the entire population in a given province (both urban and rural). In contrast, we are estimating rural poverty (as the census only covers rural Vietnam). Secondly, each estimate comes with standard errors. (We do not have the standard errors for the MOLISA poverty rates.)

The right panel of Figure 10 plots the 95% confidence interval of our income poverty estimates together with the MOLISA point estimates. We find that for 32 out of 64 provinces the MOLISA poverty rate is contained in the 95% confidence interval of our income poverty estimates.

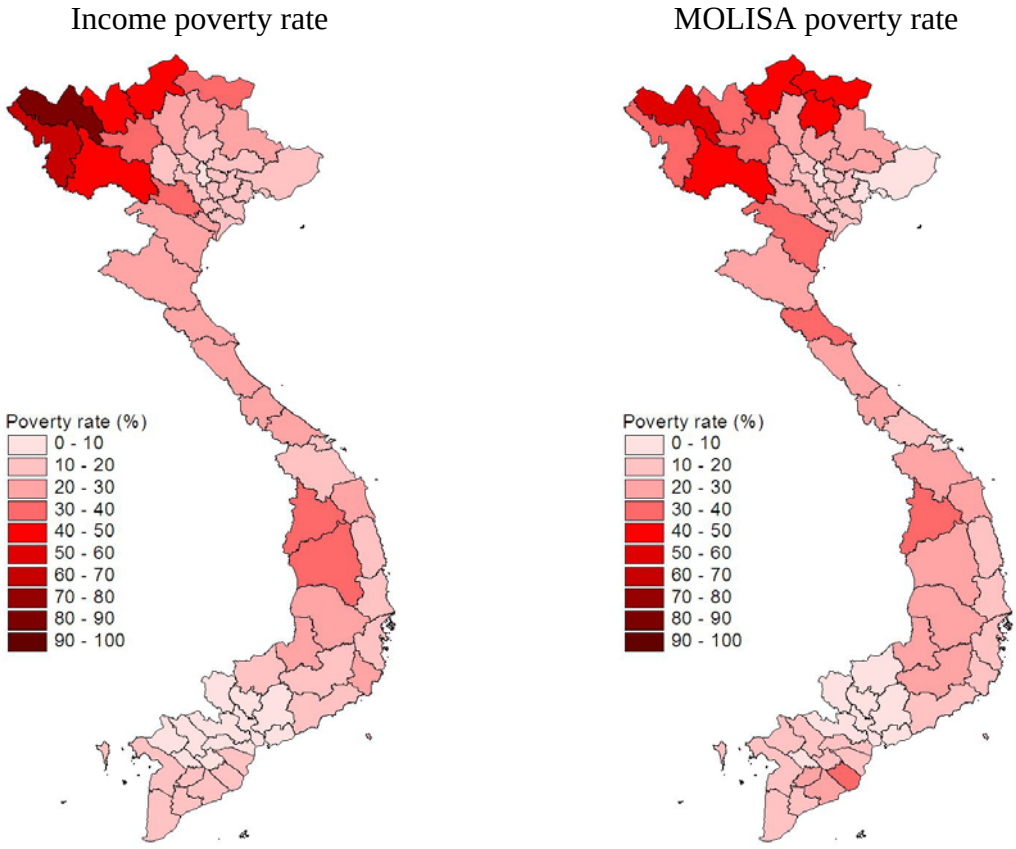
The spatial pattern of poverty at the province level shows little differences when we compare the MOLISA poverty rates with our income poverty estimates (see Figure 11).

Figure 10 MOLISA income poverty rates and the income poverty estimates of provinces



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 11 Income poverty estimates and MOLISA poverty rates of provinces

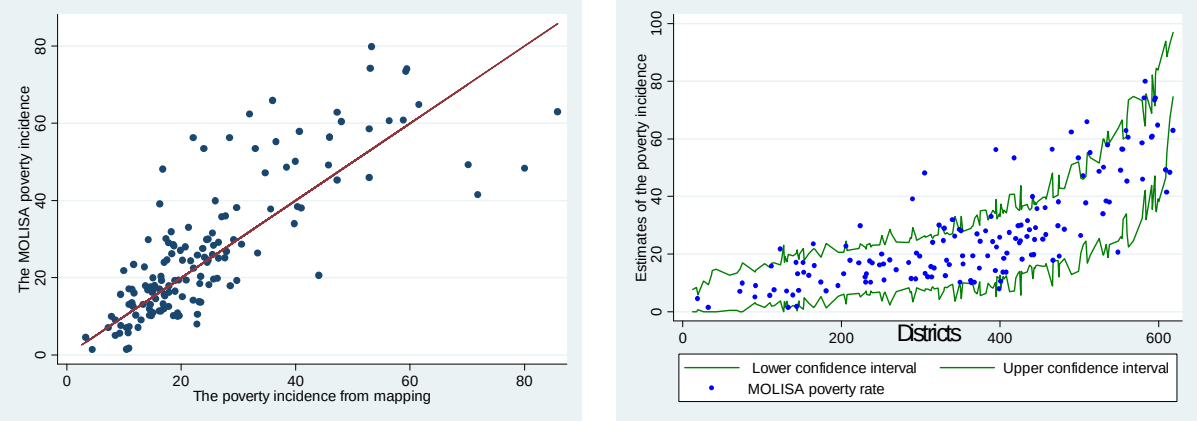


Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 12 makes a district level comparison of the MOLISA income poverty rates and our income poverty estimates. Since we do not have the MOLISA poverty rates for

the rural districts, we only keep districts with a high percentage of rural population. In our data set, there are 148 districts in which the rural population accounts for more than 95 percent of the total population. For these districts it is assumed that the MOLISA poverty rates are close to what would be the rural MOLISA poverty rates. It can be seen that the difference between the two different poverty indicators increases with the level of poverty. For 25 out of 148 districts the MOLISA poverty rate falls outside the 95% confidence interval of our income poverty estimates.

Figure 12 MOLISA income poverty rates and the income poverty estimates of districts

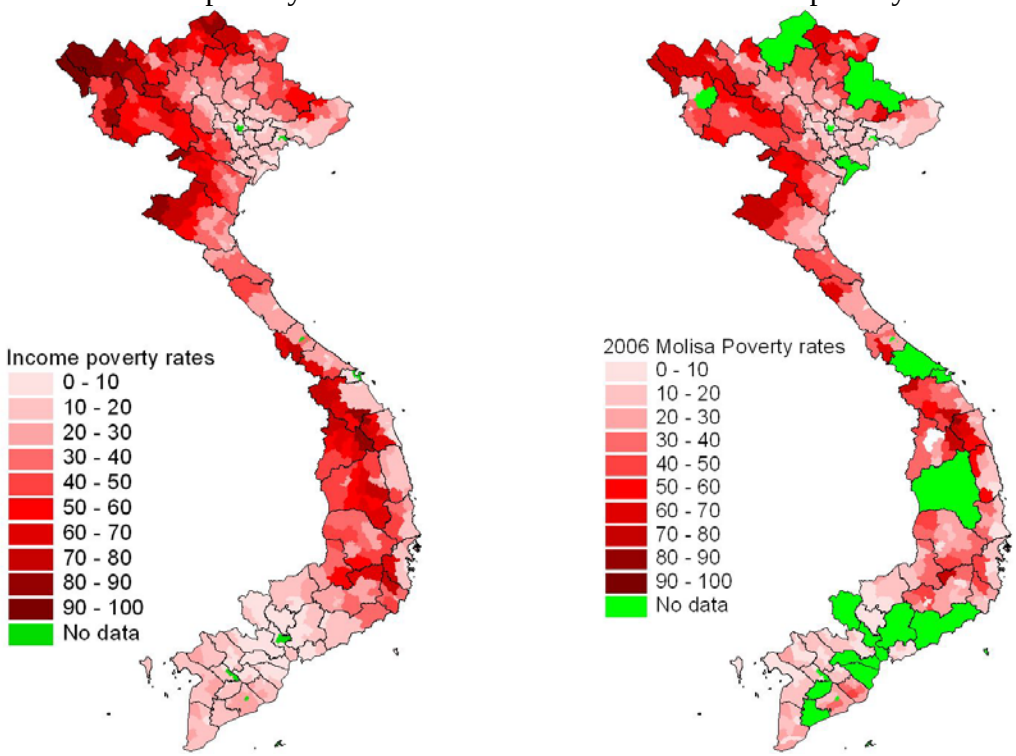


Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 13 Income poverty estimates and MOLISA poverty rates of districts

Income poverty rate

MOLISA poverty rate



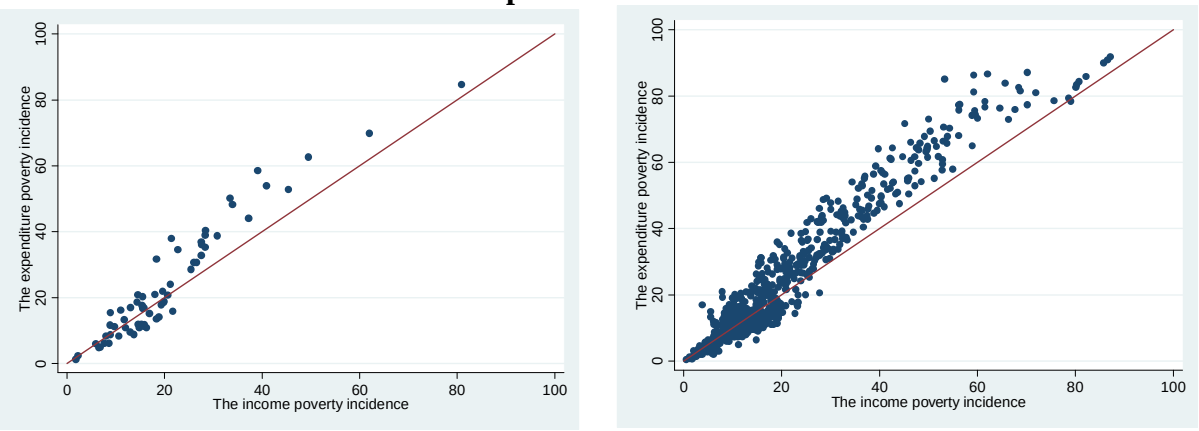
Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Figure 13 shows that the geographic pattern of the MOLISA poverty rate and our income poverty estimates are rather similar, which indicates that the difference in rankings is not very large.

VI.2 Expenditure and income based poverty

Figure 14 shows that the two different poverty indicators yield similar poverty estimates and a similar ranking at the province level. Differences can be observed for areas with higher levels of poverty, in which case expenditure poverty is found to be higher.

Figure 14 The expenditure poverty incidence and the income poverty incidence of provinces



Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table 3 reports the correlation coefficients between the two different poverty indicators. It shows that they are strongly correlated. Also correlations with the MOLISA poverty rates are rather high. Interestingly, expenditure poverty estimates appear to exhibit a stronger relation with the MOLISA poverty rates than our income poverty estimates.

Table 3 Correlation between poverty estimates

	Correlation between the provincial poverty			Correlation between the district poverty (Districts with the percentage of rural population higher than 95%)		
	Expenditure poverty rate	Income poverty rate	MOLISA poverty rate	Expenditure poverty rate	Income poverty rate	MOLISA poverty rate
Expenditure poverty rate	1			1		
Income poverty rate	0.9575	1		0.9615	1	
MOLISA poverty rate	0.8693	0.8046	1	0.8503	0.831	1

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

VII. Conclusions

We have updated the small area estimates of poverty and inequality for rural Vietnam, where existing poverty maps were outdated. These new estimates of province and district level poverty for the year 2006 allow us to examine how poverty has changed in Vietnam over the last seven years.

Vietnam has seen a remarkable reduction in (rural) poverty during the period 1999-2006. Poverty has been declining in virtually all provinces across the country. The largest improvements are observed for provinces with poverty rates close to the national average. It is found, however, that the poorest provinces have shown the lowest rates of improvements, i.e. were least successful in reducing poverty. The areas with some of the highest poverty rates are also more likely to be the areas with higher shares of ethnic minorities, which as a group are seeing below average reductions in poverty. There is found to be a noticeable gap in household endowments as well as returns to these endowments between ethnic minorities and the Kinh/Chinese people in Vietnam (see Baulch et al., 2008).

While national inequality seems to be increasing, our estimates of rural inequality within provinces and districts are relatively low. This seems to indicate that inequality is largely driven by inequality between local areas rather than within local areas. As expected, income inequality is higher than expenditure inequality. Interestingly, inequality tends to be higher in areas with relatively low poverty areas as well as in areas with relatively high poverty rates. Also, we find that provinces and districts which experienced a larger poverty reduction during the period 1999-2006 are more likely to have a lower level of inequality in 2006.

Policies that may benefit from having small area estimates of poverty and inequality include: (a) cash transfers and income support programs; (b) local government support and community development programs investing in e.g. health care, infrastructure, education, labor markets, agricultural productivity and micro finance; (c) food-and-cash for work programs; (d) fund raising and donor coordination; and (e) evaluation of country strategies, and the monitoring of progress towards millennium development goals (MDGs).

To take full advantage of the poverty maps, in particular of their policy relevance, it is key that they are accessible to a wide range of policy makers that include local entities as well as high level officials. It is not uncommon that public institutions, many of which may be potential users, are left largely unaware of the results from the poverty mapping exercise and their potential applications. Also important is that outdated estimates are replaced with up-to-date estimates of poverty and inequality.

References

Ahmad, Y. and Goh, C., 2007a, Poverty maps of Yunnan province, China: Uses and lessons for scaling up. Chapter in *More than a pretty picture: Using poverty maps to design better policies and interventions*, edited by Bedi, T., Coudouel, A. and Simler, K., The World Bank.

Ahmad, Y. and Goh, C., 2007b, Indonesia's poverty maps: Impacts and lessons. Chapter in *More than a pretty picture: Using poverty maps to design better policies and interventions*, edited by Bedi, T., Coudouel, A. and Simler, K., The World Bank.

Bedi, T., Coudouel, A. and Simler, K., 2007, *More than a pretty picture: using poverty maps to design better policies and interventions*, The World Bank.

Bigman, D. and Fofack, H., 2000, *Geographic targeting for poverty alleviation: methodology and applications*. Washington DC: World Bank Regional and Sectoral Studies.

Elbers, C., Fujii, T., Lanjouw, P., Ozler, B., Yin, W., 2007, Poverty alleviation through geographic targeting: How much does disaggregation help? *Journal of Development Economics*, 83, pp.198-213.

Elbers, C., Lanjouw, J. and Lanjouw, P., 2002, Micro-Level estimation of welfare. Policy Research Working Paper No. WPS 2911. The World Bank.

Elbers, C., Lanjouw, J. and Lanjouw, P., 2003, Micro-level estimation of poverty and inequality, *Econometrica*, 71(1), pp. 355-364.

Foster, J., Greer, J., Thorbecke, E., 1984, A class of decomposable poverty measures. *Econometrica*, **52 (3)**, pp. 761-766.

Fujii, T. and Roland-Holst, D., 2008, How does Vietnam's accession to the world trade organization change the spatial incidence of poverty? Policy Research Working Paper 4521, The World Bank.

Fujii, T., 2007, Policy effectiveness of poverty maps: Experiences from Mexico and Cambodia. Chapter in *More than a pretty picture: Using poverty maps to design better policies and interventions*, edited by Bedi, T., Coudouel, A. and Simler, K., The World Bank.

Gian, T. C. and van der Weide, R., 2007, Verification of earlier national poverty maps using VLSS1998 and National Population Census 1999. Research report for the Ministry of Labour, War Invalids and Social Affairs of Vietnam.

Gotcheva, B., 2007, Bulgaria: Poverty map country application. Chapter in More *than a pretty picture: Using poverty maps to design better policies and interventions*, edited by Bedi, T., Coudouel, A. and Simler, K., The World Bank.

Minot, N., Baulch, B., and Epprecht, M., 2003, Poverty and Inequality in Vietnam: Spatial Patterns and Geographic Determinants. Final report of project "Poverty Mapping and Market Access in Vietnam" conducted by IFPRI and IDS.

Nguyen, V. C., Nguyen, P., and Ngo, T., 2005, Construction of poverty map for HCM city using the 2002 VHLSS and the 2004 HCM Mid-Census, Research report for Institute of Economics, Ho Chi Minh city, Vietnam.

Nguyen, V. C., Tran, N. T., and Nguyen, H., 2007, Construction of poverty map for HCM city using the 2004 VHLSS and the 2004 HCM Mid-Census, Research report for the Ministry of Labour, War Invalids and Social Affairs of Vietnam..

Nguyen, V. C., Tran, N. T., and van der Weide, R., 2007, Updating Poverty Map of Vietnam using Vietnam Household Living Standard Survey 2002 and Population Census 1999. Research report for the Ministry of Labour, War Invalids and Social Affairs of Vietnam.

Tarozzi, A. and A. Deaton, 2009, Using census and survey data to estimate poverty and inequality for small areas. Review of Economics and Statistics, 91(4), pp. 773-792.

Tran N. T., 2007, Construction of poverty mapping for seven provinces using the data of 2004 VHLSS and the 2006 Rural Agriculture and Fishery Census, Research report the Ministry of Labour, War Invalids and Social Affairs of Vietnam.

World Bank, 2003, Vietnam development report 2004: Poverty. Joint Donor Report to the Vietnam Consultative Group Meeting Hanoi, December 2-3, 2003.

World Bank, 2007, Vietnam development report 2004: Social protection. Joint Donor Report to the Vietnam Consultative Group Meeting Hanoi, December 6-7, 2007.

Baulch, B., Pham, H. T. and Reilly, B., 2008, Decomposing the ethnic gap in living standards in rural Vietnam: 1993 to 2004. A mimeo, Institute of Development Studies, University of Sussex.

Appendix

Table A.1 Common household variables between the 2006 VHLSS and the 2006 RAFC

Variable	Type
Household variables	
Ethnic minorities (yes=1)	Binary
Household size	Discrete
Permanent house	Binary
Semi-permanent house	Binary
Temporary house	Binary
Tap water	Binary
Clean water	Binary
Other water	Binary
Flush toilet	Binary
Other toilets	Binary
No toilet	Binary
Have radio	Binary
Have computer	Binary
Have motorbike	Binary
Have color television	Binary
Have mobile	Binary
Have telephone	Binary
Have refrigerator	Binary
Have fan	Binary
Proportion of female members to working members	Continuous
Proportion of working member to household size	Continuous
Proportion of service members to working members	Continuous
Proportion of working members without vocational training	Continuous
Proportion of working members with vocational training	Continuous
Proportion of working members with college/university	Continuous
Log of per capita living area (log of m2)	Binary
Have or own annual land (yes=1)	Binary
Commune variables	
Commune have national electricity system cover all villages	Binary
The road to this commune center is concrete and always available in year	Binary
Proportion of concrete road in commune	Continuous
Numbers of primary schools per 1000 households	Discrete
Numbers of secondary schools per 1000 households	Discrete
Number of irrigation per 1000 households	Discrete
Number of extension staff per 1000 households	Discrete
Number of markets per 1000 households	Discrete
Number of concrete markets per 1000 households	Discrete
Have bank branch	Binary
GIS variables at the district level	
Percentage of area elevation lower than 250m in total area	Continuous
Percentage of area slope lower 4 degree in total area	Continuous
Mean elevation (m)	Continuous
Mean sunshine (annual hours)	Continuous
Mean temperature (degree Celsius)	Continuous
Mean rainfall (mms)	Continuous

Table A.2 Expenditure and income regressions: Red River Delta

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.935	0.082	0.000	8.067	0.106	0.000
Household variables						
Have computer	0.197	0.060	0.001			
Have color TV				0.289	0.037	0.000
Have mobile	0.203	0.022	0.000	0.305	0.047	0.000
Have motorbike	0.154	0.033	0.000	0.179	0.029	0.000
Have refrigerator	0.135	0.028	0.000			
Have telephone	0.176	0.026	0.000	0.181	0.035	0.000
Household size	-0.056	0.008	0.000	-0.073	0.011	0.000
Log of living area per capita	0.114	0.021	0.000	0.094	0.030	0.002
Flush toilet	0.135	0.024	0.000			
Permanent house type				0.084	0.028	0.003
Proportion of working members without vocational training	-0.152	0.030	0.000	-0.171	0.042	0.000
Proportion of working member to household size	0.340	0.039	0.000	0.433	0.055	0.000
Flush toilet				0.163	0.034	0.000
Commune variables						
Proportion of households having mobile in commune	0.583	0.168	0.001	0.814	0.212	0.000
Proportion of concrete road in commune	0.098	0.037	0.008			
Proportion of household having no toilet in commune				-1.040	0.453	0.022
Number of obs.	1521					
Number of cluster	92			1521		
Adj-Rsquared	0.439			94		
Rho[5]	0.096			0.387		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.3 Expenditure and income regressions: North East

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	8.098	0.141	0.000	8.487	0.174	0.000
Household variables						
Have fan	0.118	0.030	0.000			
Have mobile	0.201	0.054	0.000	0.312	0.070	0.000
Have color TV				0.221	0.032	0.000
Have motorbike	0.271	0.025	0.000	0.207	0.031	0.000
Have refrigerator	0.160	0.045	0.001			
Have telephone	0.119	0.043	0.006	0.138	0.053	0.009
Ethnic minority	-0.064	0.033	0.049	-0.084	0.039	0.032

[5] Rho is the ratio of $\hat{\sigma}_{\eta}^{2} / \hat{\sigma}_{u}^{2}$, which measures the relative component of location errors in the total errors in the model.

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Household size	-0.122	0.028	0.000	-0.053	0.010	0.000
Household size squared	0.006	0.002	0.014			
Temporary house type	-0.139	0.030	0.000	-0.105	0.035	0.003
Log of living area per capita	0.146	0.030	0.000	0.198	0.034	0.000
No toilet	-0.124	0.041	0.002			
Others water	-0.106	0.029	0.000			
Proportion of working members without vocational training	-0.243	0.044	0.000	-0.347	0.054	0.000
Proportion of service members to working members	0.116	0.045	0.010	0.248	0.057	0.000
Proportion of working member to household size	0.160	0.051	0.002	0.288	0.064	0.000
Commune variables						
Commune proportion of service members to working members	0.487	0.172	0.005			
Average of household size in commune				-0.086	0.031	0.005
Proportion of concrete road in commune				0.147	0.064	0.022
Number of obs.	1017			1017		
Number of cluster	105			105		
Adj-Rsquared	0.571			0.528		
Rho	0.136			0.100		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.4 Expenditure and income regressions: North West

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.749	0.196	0.000	8.143	0.242	0.000
Household variables						
Have color TV				0.206	0.049	0.000
Have computer				0.512	0.214	0.017
Have mobile				0.501	0.153	0.001
Have fan	0.154	0.044	0.001			
Have motorbike	0.327	0.042	0.000	0.196	0.048	0.000
Have refrigerator	0.235	0.089	0.009			
Ethnic minority	-0.254	0.068	0.000	-0.193	0.085	0.024
Household size	-0.044	0.012	0.000			
Log of living area per capita	0.215	0.051	0.000	0.271	0.053	0.000
Flush toilet	0.249	0.085	0.004			
No toilet	-0.250	0.058	0.000	-0.300	0.066	0.000
Proportion of working members without vocational training	-0.192	0.082	0.020	-0.823	0.175	0.000
Proportion of working members with vocational training				-0.766	0.221	0.001
Proportion of working member to household size				0.432	0.131	0.001
No clean water				-0.122	0.061	0.046
Commune variables						

Proportion of households having color TV in commune						
Proportion of household having tap-water in commune				3.308	1.399	0.019
Number of obs.	346			346		
Number of cluster	33			33		
Adj-Rsquared	0.595			0.551		
Rho	0.112			0.082		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.5 Expenditure and income regressions: North Central Coast

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.487	0.169	0.000	8.009	0.196	0.000
Household variables						
Have fan	0.140	0.035	0.000			
Have motorbike	0.281	0.027	0.000	0.258	0.039	0.000
Have refrigerator	0.251	0.057	0.000	0.253	0.077	0.001
Have telephone	0.198	0.042	0.000	0.309	0.057	0.000
Household size	-0.050	0.010	0.000	-0.054	0.014	0.000
Temporary house type	-0.142	0.044	0.001	-0.224	0.061	0.000
Log of living area per capita	0.186	0.033	0.000	0.208	0.045	0.000
No toilet	-0.197	0.043	0.000			
Have color TV				0.212	0.042	0.000
Have mobile				0.236	0.086	0.006
Proportion of working members without vocational training	-0.174	0.056	0.002	-0.300	0.070	0.000
Proportion of service members to working members	0.173	0.048	0.000			
Proportion of working member to household size	0.378	0.057	0.000	0.415	0.081	0.000
Commune variables						
Proportion of households having color TV in commune	0.399	0.102	0.000			
Proportion of households having others toilet in commune	-0.280	0.070	0.000	-0.230	0.090	0.010
Proportion of household having permanent house in commune				0.627	0.173	0.000
Number of obs.	849			849		
Number of cluster	76			76		
Adj-Rsquared	0.542			0.466		
Rho	0.102			0.038		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.6 Expenditure and income regressions: South Central Coast

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.535	0.103	0.000	7.982	0.175	0.000
Household variables						
Have mobile				0.341	0.079	0.000
Have motorbike	0.281	0.033	0.000	0.265	0.046	0.000
Have telephone	0.248	0.045	0.000	0.292	0.066	0.000
Ethnic minority	-0.367	0.067	0.000	-0.206	0.072	0.004
Log of living area per capita	0.260	0.029	0.000	0.178	0.047	0.000
No toilet	-0.082	0.033	0.014			
Household size				-0.058	0.016	0.000
Temporary house				-0.203	0.062	0.001
Flush toilet				0.118	0.054	0.029
Proportion of working members without vocational training	-0.330	0.053	0.000	0.409	0.113	0.000
Proportion of service members to working members	0.112	0.046	0.015			
Proportion of working member to household size	0.365	0.071	0.000	0.169	0.079	0.032
Number of obs.	585			585		
Number of cluster	53			53		
Adj-Rsquared	0.529			0.445		
Rho	0.066			0.078		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.7 Expenditure and income regressions: Central Highland

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.735	0.165	0.000	7.744	0.184	0.000
Household variables						
Have mobile	0.254	0.076	0.001	0.322	0.087	0.000
Have motorbike	0.362	0.040	0.000	0.331	0.051	0.000
Have telephone	0.326	0.075	0.000	0.254	0.083	0.002
Ethnic minority	-0.332	0.047	0.000	-0.334	0.057	0.000
Household size	-0.227	0.056	0.000	-0.028	0.012	0.015
Log of living area per capita	0.276	0.042	0.000	0.277	0.052	0.000
No toilet	-0.127	0.049	0.009	-0.183	0.059	0.002
Temporary house type				-0.191	0.059	0.001
Proportion of working member to household size				0.452	0.116	0.000
Permanent house type				0.234	0.103	0.023
Have radio				-0.180	0.078	0.022
Others water	-0.141	0.048	0.003			
Number of obs.	404			404		
Number of cluster	54			54		
Adj-Rsquared	0.695			0.616		
Rho	0.177			0.091		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.8 Expenditure and income regressions: South East

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.604	0.120	0.000	7.806	0.137	0.000
Household variables						
Have computer	0.167	0.062	0.008			
Have refrigerator	0.225	0.042	0.000			
Have telephone	0.129	0.038	0.001	0.211	0.048	0.000
Ethnic minority	-0.289	0.062	0.000	-0.355	0.073	0.000
Household size	-0.037	0.009	0.000			
Log of living area per capita	0.250	0.032	0.000	0.265	0.037	0.000
Flush toilet	0.194	0.039	0.000	0.188	0.049	0.000
Proportion of working members with vocational training	0.219	0.086	0.011			
Have color TV				0.129	0.053	0.015
Have mobile				0.208	0.057	0.000
Have motorbike	0.311	0.040	0.000	0.165	0.053	0.002
Proportion of working members without vocational training				-0.206	0.071	0.004
Proportion of working member to household size				0.476	0.091	0.000
Clean water	0.098	0.040	0.015			
Commune variables						
Proportion of households having temporary house in commune	-0.585	0.187	0.002			
Proportion of households having radio in commune	0.465	0.194	0.017			
Number of obs.	639			639		
Number of cluster	60			60		
Adj-Rsquared	0.619			0.530		
Rho	0.136			0.146		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.9 Expenditure and income regressions: Mekong River Delta

	Per capita expenditure			Per capita income		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Intercept	7.642	0.095	0.000	9.039	0.311	0.000
Household variables						
Have annual land	0.048	0.020	0.019			
Have fan	0.133	0.022	0.000			
Have mobile	0.174	0.033	0.000	0.249	0.060	0.000
Have motorbike	0.189	0.023	0.000	0.222	0.041	0.000
Have refrigerator	0.192	0.032	0.000	0.298	0.062	0.000
Have telephone	0.179	0.027	0.000			
Ethnic minority	-0.125	0.043	0.004	-0.153	0.071	0.031
Household size	-0.044	0.007	0.000	-0.032	0.014	0.022
Temporary house	-0.103	0.022	0.000	-0.259	0.077	0.001
Log of living area per capita	0.227	0.023	0.000	0.183	0.043	0.000
Have radio				0.093	0.045	0.038
Have color TV				0.190	0.043	0.000

Proportion of working members without vocational training				-0.182	0.075	0.015
Proportion of working members with vocational training	0.190	0.065	0.004			
Proportion of working members with college/university	0.340	0.089	0.000			
Proportion of working members to household size	0.143	0.036	0.000	0.445	0.081	0.000
Commune variables						
Proportion of households having mobile in commune	0.776	0.248	0.002	1.077	0.410	0.009
Average log of living area per capita in commune				-0.362	0.103	0.000
Number of obs.	1466			1466		
Number of cluster	111			111		
Adj-Rsquared	0.512			0.351		
Rho	0.166			0.044		

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.10 Poverty and inequality estimates at the provincial level

	Expenditure poverty and inequality						Income poverty and inequality					
	Poverty rate (%)		Poverty Gap		Gini		Poverty rate (%)		Poverty Gap		Gini	
	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Ha Noi	4.8	1.3	0.0081	0.0026	0.2871	0.0128	4.8	1.3	0.0081	0.0026	0.2871	0.0128
Hai Phong	11.8	2.2	0.0209	0.0049	0.2514	0.0068	11.8	2.2	0.0209	0.0049	0.2514	0.0068
Vinh Phuc	13.5	2.5	0.0242	0.0056	0.2360	0.0075	13.5	2.5	0.0242	0.0056	0.2360	0.0075
Ha Tay	11.9	1.6	0.0213	0.0035	0.2481	0.0063	11.9	1.6	0.0213	0.0035	0.2481	0.0063
Bac Ninh	9.6	1.9	0.0166	0.0040	0.2560	0.0092	9.6	1.9	0.0166	0.0040	0.2560	0.0092
Hai Duong	10.8	1.8	0.0184	0.0039	0.2312	0.0055	10.8	1.8	0.0184	0.0039	0.2312	0.0055
Hung Yen	11.9	1.9	0.0210	0.0041	0.2344	0.0055	11.9	1.9	0.0210	0.0041	0.2344	0.0055
Ha Nam	14.1	3	0.0254	0.0069	0.2315	0.0068	14.1	3	0.0254	0.0069	0.2315	0.0068
Nam Dinh	10.8	1.8	0.0186	0.0037	0.2306	0.0052	10.8	1.8	0.0186	0.0037	0.2306	0.0052
Thai Binh	11.3	1.9	0.0194	0.0042	0.2297	0.0053	11.3	1.9	0.0194	0.0042	0.2297	0.0053
Ninh Binh	15.8	3.1	0.0292	0.0073	0.2355	0.0064	15.8	3.1	0.0292	0.0073	0.2355	0.0064
Ha Giang	62.7	3.9	0.1765	0.0197	0.2537	0.0100	62.7	3.9	0.1765	0.0197	0.2537	0.0100
Cao Bang	48.2	3.2	0.1279	0.0152	0.2916	0.0109	48.2	3.2	0.1279	0.0152	0.2916	0.0109
Lao Cai	53.9	3.9	0.1480	0.0180	0.2738	0.0108	53.9	3.9	0.1480	0.0180	0.2738	0.0108
Bac Kan	36.9	4.2	0.0886	0.0142	0.2553	0.0076	36.9	4.2	0.0886	0.0142	0.2553	0.0076
Lang Son	40.4	3.8	0.0956	0.0132	0.2635	0.0076	40.4	3.8	0.0956	0.0132	0.2635	0.0076
Tuyen Quang	28.6	4.8	0.0628	0.0138	0.2799	0.0097	28.6	4.8	0.0628	0.0138	0.2799	0.0097
Yen Bai	38.8	4.4	0.0969	0.0156	0.2693	0.0094	38.8	4.4	0.0969	0.0156	0.2693	0.0094
Thai Nguyen	21.9	3.3	0.0438	0.0085	0.2693	0.0071	21.9	3.3	0.0438	0.0085	0.2693	0.0071
Phu Tho	20.9	3.2	0.0405	0.0087	0.2676	0.0088	20.9	3.2	0.0405	0.0087	0.2676	0.0088
Bac Giang	17.6	2.7	0.0341	0.0067	0.2501	0.0078	17.6	2.7	0.0341	0.0067	0.2501	0.0078
Quang Ninh	20.3	2.9	0.0425	0.0072	0.2839	0.0078	20.3	2.9	0.0425	0.0072	0.2839	0.0078
Lai Chau	84.6	2.9	0.3551	0.0292	0.2745	0.0118	84.6	2.9	0.3551	0.0292	0.2745	0.0118
Dien Bien	69.9	3.8	0.2559	0.0245	0.2907	0.0163	69.9	3.8	0.2559	0.0245	0.2907	0.0163
Son La	52.8	3.8	0.1562	0.0181	0.2718	0.0103	52.8	3.8	0.1562	0.0181	0.2718	0.0103
Hoa Binh	44.1	4.3	0.1132	0.0174	0.2694	0.0103	44.1	4.3	0.1132	0.0174	0.2694	0.0103
Thanh Hoa	36.1	2.4	0.0861	0.0080	0.2764	0.0057	36.1	2.4	0.0861	0.0080	0.2764	0.0057
Nghe An	32.8	2.8	0.0814	0.0087	0.2910	0.0065	32.8	2.8	0.0814	0.0087	0.2910	0.0065

	Expenditure poverty and inequality						Income poverty and inequality					
	Poverty rate (%)		Poverty Gap		Gini		Poverty rate (%)		Poverty Gap		Gini	
	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Ha Tinh	30.7	3.1	0.0679	0.0098	0.2673	0.0066	30.7	3.1	0.0679	0.0098	0.2673	0.0066
Quang Binh	30.7	4.2	0.0721	0.0135	0.2872	0.0082	30.7	4.2	0.0721	0.0135	0.2872	0.0082
Quang Tri	35.3	3.6	0.0962	0.0122	0.2903	0.0071	35.3	3.6	0.0962	0.0122	0.2903	0.0071
Thua Thien Hue	24.0	2.6	0.0564	0.0081	0.2987	0.0073	24.0	2.6	0.0564	0.0081	0.2987	0.0073
Da Nang	8.3	3.4	0.0137	0.0066	0.2353	0.0054	8.3	3.4	0.0137	0.0066	0.2353	0.0054
Quang Nam	17.8	1.6	0.0406	0.0041	0.2569	0.0072	17.8	1.6	0.0406	0.0041	0.2569	0.0072
Quang Ngai	20.7	1.9	0.0493	0.0055	0.2633	0.0070	20.7	1.9	0.0493	0.0055	0.2633	0.0070
Binh Dinh	15.2	1.9	0.0281	0.0043	0.2387	0.0063	15.2	1.9	0.0281	0.0043	0.2387	0.0063
Phu Yen	18.8	2.1	0.0400	0.0053	0.2514	0.0063	18.8	2.1	0.0400	0.0053	0.2514	0.0063
Khanh Hoa	18.5	2.2	0.0429	0.0059	0.2709	0.0063	18.5	2.2	0.0429	0.0059	0.2709	0.0063
Kon Tum	58.5	3.4	0.1951	0.0208	0.3416	0.0105	58.5	3.4	0.1951	0.0208	0.3416	0.0105
Gia Lai	50.1	2.7	0.1677	0.0158	0.3438	0.0089	50.1	2.7	0.1677	0.0158	0.3438	0.0089
Dak Lak	34.5	2.8	0.0978	0.0116	0.3219	0.0088	34.5	2.8	0.0978	0.0116	0.3219	0.0088
Da Nang	37.9	4.8	0.1051	0.0188	0.3039	0.0119	37.9	4.8	0.1051	0.0188	0.3039	0.0119
Lam Dong	31.6	3.5	0.0889	0.0138	0.3480	0.0123	31.6	3.5	0.0889	0.0138	0.3480	0.0123
Ho Chi Minh	2.3	0.9	0.0035	0.0017	0.2772	0.0106	2.3	0.9	0.0035	0.0017	0.2772	0.0106
Ninh Thuan	39.0	5.4	0.1061	0.0202	0.2797	0.0117	39.0	5.4	0.1061	0.0202	0.2797	0.0117
Binh Phuoc	16.1	2.8	0.0341	0.0077	0.2942	0.0107	16.1	2.8	0.0341	0.0077	0.2942	0.0107
Tay Ninh	6.2	1.6	0.0094	0.0032	0.2515	0.0100	6.2	1.6	0.0094	0.0032	0.2515	0.0100
Binh Duong	1.3	0.5	0.0017	0.0009	0.2724	0.0104	1.3	0.5	0.0017	0.0009	0.2724	0.0104
Dong Nai	8.3	1.6	0.0156	0.0037	0.2894	0.0092	8.3	1.6	0.0156	0.0037	0.2894	0.0092
Binh Thuan	16.9	2.9	0.0353	0.0081	0.2830	0.0095	16.9	2.9	0.0353	0.0081	0.2830	0.0095
Vung Tau	5.9	1.9	0.0095	0.0037	0.2776	0.0091	5.9	1.9	0.0095	0.0037	0.2776	0.0091
Long An	4.9	1.3	0.0077	0.0025	0.2475	0.0073	4.9	1.3	0.0077	0.0025	0.2475	0.0073
Dong Thap	11.7	2.3	0.0205	0.0050	0.2573	0.0072	11.7	2.3	0.0205	0.0050	0.2573	0.0072
An Giang	15.4	3.4	0.0291	0.0083	0.2567	0.0070	15.4	3.4	0.0291	0.0083	0.2567	0.0070
Tien Giang	6.2	1.8	0.0104	0.0037	0.2620	0.0086	6.2	1.8	0.0104	0.0037	0.2620	0.0086
Vinh Long	8.7	2.7	0.0144	0.0056	0.2570	0.0089	8.7	2.7	0.0144	0.0056	0.2570	0.0089
Ben Tre	8.8	2.3	0.0155	0.0050	0.2649	0.0077	8.8	2.3	0.0155	0.0050	0.2649	0.0077

	Expenditure poverty and inequality						Income poverty and inequality					
	Poverty rate (%)		Poverty Gap		Gini		Poverty rate (%)		Poverty Gap		Gini	
	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
Kien Giang	18.6	3.5	0.0365	0.0089	0.2643	0.0071	18.6	3.5	0.0365	0.0089	0.2643	0.0071
Can Tho	11.1	3.4	0.0190	0.0074	0.2551	0.0123	11.1	3.4	0.0190	0.0074	0.2551	0.0123
Hau Giang	10.8	3.3	0.0179	0.0068	0.2462	0.0083	10.8	3.3	0.0179	0.0068	0.2462	0.0083
Tra Vinh	16.7	3.9	0.0321	0.0096	0.2596	0.0067	16.7	3.9	0.0321	0.0096	0.2596	0.0067
Soc Trang	20.8	3.4	0.0431	0.0094	0.2673	0.0069	20.8	3.4	0.0431	0.0094	0.2673	0.0069
Bac Lieu	13.3	2.8	0.0251	0.0067	0.2718	0.0089	13.3	2.8	0.0251	0.0067	0.2718	0.0089
Ca Mau	17.0	3.1	0.0351	0.0081	0.2843	0.0094	17.0	3.1	0.0351	0.0081	0.2843	0.0094

Source: Authors' estimation from VHLSS 2006 and ARFC 2006

Table A.11 Matrix of correlation coefficients between household variables.

	hhsize	ethnic	pedu0	pedu1	pedu2	pwork	House	Toilet	Water	Radio	Tv	Comp.	Telep.	mobile	Motor.	Fan	Refrig erator
Household size	1																
Ethnic minorities	0.23	1															
pedu0	0.34	0.13	1														
pedu1	-0.02	-0.06	-0.53	1													
pedu2	-0.01	-0.06	-0.32	0.02	1												
pwork	-0.01	0.00	0.42	0.08	0.02	1											
Housing type	-0.02	0.16	0.07	-0.12	-0.09	-0.01	1										
Toilet	0.04	0.25	0.13	-0.16	-0.16	-0.02	0.33	1									
Water	0.14	0.41	0.11	-0.07	-0.07	0.01	0.18	0.26	1								
Radio	0.01	-0.03	-0.03	0.03	0.02	0.02	0.02	-0.03	-0.01	1							
Television	0.09	-0.24	0.00	0.15	0.09	0.10	-0.28	-0.27	-0.22	-0.02	1						
Computer	0.01	-0.07	-0.16	0.14	0.31	0.00	-0.08	-0.17	-0.07	0.03	0.09	1					
Telephone	0.01	-0.17	-0.15	0.20	0.19	0.02	-0.23	-0.34	-0.18	0.05	0.26	0.24	1				
Mobile	0.06	-0.11	-0.13	0.20	0.21	0.04	-0.13	-0.23	-0.13	0.05	0.17	0.27	0.36	1			
Motorbike	0.22	-0.10	0.04	0.18	0.14	0.13	-0.21	-0.24	-0.11	0.01	0.37	0.13	0.31	0.25	1		
Fan	-0.07	-0.33	-0.07	0.11	0.07	0.02	-0.27	-0.25	-0.25	0.01	0.39	0.06	0.19	0.13	0.21	1	
Refrigerator	0.02	-0.11	-0.13	0.17	0.18	0.00	-0.21	-0.30	-0.14	0.05	0.20	0.24	0.43	0.35	0.27	0.14	1

Note: variable abbreviation:
pedu0: Proportion of members without vocational training
pedu1: Proportion of members with vocational training
pedu2: Proportion of members with college/university
pwork: Proportion of working members

Source: Authors' estimation from VHLSS